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*Swietenia mahagoni* Jacq.—commonly called West Indies mahogany, small leaf mahogany, caoba, caoba Dominicana, or acajou—is normally a medium-sized tree, but lives a long time and can reach very large sizes. West Indies mahogany was once the most sought after cabinet wood in the world. The species grows at a moderate rate. It is planted as an ornamental and managed in plantations and natural stands in dry and moist forests (fig. 1).

## HABITAT

### Native Range

The native range of West Indies mahogany includes the southern tip of Florida, the Florida Keys, the Bahamas, Cuba, Jamaica, and the island of Hispaniola (5, 23, 25, 47, fig. 2). The species is planted as an ornamental outside its natural range in Florida, several Caribbean islands, Hawaii, India, Sri Lanka, and Fiji (36, 47, 57). It has naturalized or escaped in a number of sites in Puerto Rico and the U.S. Virgin Islands (author, personal observation).

### Climate

The species is reportedly best adapted to areas with annual precipitation ranging from 760 mm to 1780 mm (29). An annual dry season of 2 to 6 months normally occurs within the native range. The Florida provenance is able to withstand occasional frosts without major damage (8).

### Soils and Topography

West Indies mahogany grows on a variety of sites within its native range. It is tolerant of relatively high pH (up to about 8.5). It may be found on areas that receive salt spray and on soils with marl and limestone parent materials just inland from the mangroves (6). The species frequently dominates on pockets of deeper soil on dry limestone ridges and may be found growing on all slopes and aspects. In Jamaica, natural stands grow from near sea level to about 900 m elevation (50). West Indies mahogany grows well in plantations on moist and deep soils, but rarely survives competition with faster growing species in natural stands on good sites. The species is limited by cool, moist conditions and low pH soils,

particularly soils with clayey textures. Several plantation stands in Puerto Rico that were planted on clay soils with pH's around 5.0 and rainfall above 2250 mm per year have died out completely (author, personal observation).

### Associated Forest Cover

In Florida, a typical vegetation type colonized by West Indies mahogany is the tropical hardwood hammocks that support *Piscidia piscipula* (L.) Sarg., *Bursera simaruba* (L.) Sarg., *Lysiloma latisiliquum* (L.) Benth., *Amyris elemifera* L., *Canella winterana* (L.) Gaertn., *Guapira discolor* (Spreng.) Little, *Drypetes diversifolia* King & Urban, *D. lateriflora* (Sw.) Krug & Urban, *Gymnanthes lucida* Sw., *Bumelia celastrina* H.B.K., *Mastichodendron foetidissimum* (Jacq.) H.J. Lam, *Schaefferia frutescens* Jacq., *Cordia sebestena* L., *Coccoloba uvifera* (L.) L., *C. diversifolia* Jacq., *Krugiodendron ferreum* (Vahl) Urban, *Hypelate trifoliata* Sw., *Suriana maritima* L., and *Metopium toxiferum* (L.) Krug & Urban (6). If protected from fire, West Indies mahogany will invade adjacent forests occupied by the *Pinus elliotii* Engelm.—*Serenoa repens* (Bertr.) Small type (8).

In the Sierra Maestra Mountains of Cuba on seaward slopes up to 500 m elevation, West Indies mahogany grows with *Behaimia cubensis* Griseb., *Bunchosia media* (Ait.) DC., *Carpodiptera cubensis* Griseb., *Colubrina reclinata* (L'Her.) Brong., *Cordia geracanthus* L., *Dipholis salicifolia* (L.) A. DC., *Eugenia floribunda* West, *Exothea paniculata* (Juss.) Radlk., *Gymnanthes lucida* Sw., and *Oxandra lanceolata* (Sw.) Bail. (44). The subtropical moist forest of the Dominican Republic



Figure 1.—Thirteen-year-old West Indies mahogany (*Swietenia mahagoni*) plantation growing in Puerto Rico.

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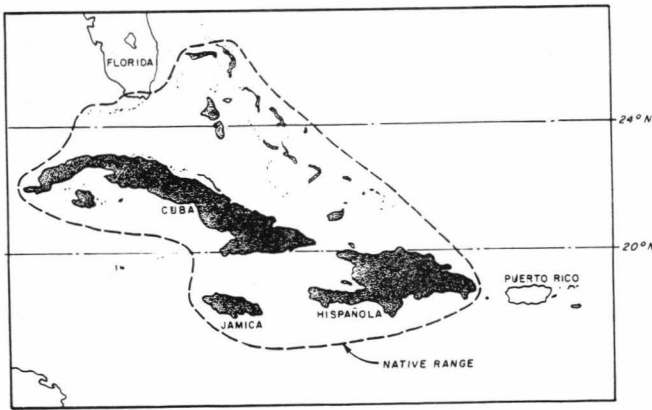


Figure 2.—Native range of West Indies mahogany (*Swietenia mahagoni*) in the West Indies.

survives only in scattered remnants, mostly on steep and remote terrain. Dominant species associated with West Indies mahogany are *Cedrela odorata* L., *Petitia domingensis* Jacq., *Catalpa longissima* (Jacq.) Dum. Cours., and *Juglans jamaicensis* C. DC. (52). West Indies mahogany may also be found in the subtropical dry forest on Hispaniola in association with *Phyllostylon brasiliensis* Capan., *Caesalpinia coriaria* (Jacq.) Willd., *Acacia macracantha* H. & B. ex Willd., *Haematoxylon campechianum* L., *Guaiacum officinale* L., *Guaiacum sanctum* L., and *Colubrina arborescens* (Miller) Sarg. (18).

## LIFE HISTORY

### Reproduction and Early Growth

**Flowering and Fruiting.**—The flowers are unisexual and the trees are monoecious, with male and female flowers present in each inflorescence (20, 48). The flowers are apparently pollinated by bees and moths (49). Flowering and fruiting of plantation trees starts at 12 to 13 years of age (18). Only dominant and codominant trees produce seeds (author, personal observation). The fruit is a brown, egg- to pear-shaped capsule about 6 to 10 cm long (43). When fully ripe, the woody shell splits in five sections from the base upward and falls off to release the seeds. The winged seeds are 5 to 6 cm long and tan to reddish brown in color (2).

**Seed Production and Dissemination.**—Seed production is irregular from year to year (51). A capsule may contain up to 60 seeds (9). Fifty capsules sampled from a number of trees in Puerto Rico averaged  $39.9 \pm 1.3$  seeds and ranged from 19 to 56 seeds per capsule (author, personal observation). Large trees produce a few to over 100 capsules. There are about 7,000 air-dried seeds per kilogram (28). The winged seeds spin and fly sideways as they descend. The seeds are not known to be transported by animals. Without the aid of humans, the spread of West Indies mahogany into new habitat is fairly slow.

**Seeding Development.**—Germination is hypogeal. An average of 70-percent germination was noted in tests in Puerto Rico, and an average time lapse of 18 days was noted before the first seeds germinated (28).

Formerly, seedlings were planted as “striplings”—bare-root seedlings with all the leaves stripped off. Stripping off the leaves apparently protected the seedlings from transpiration stress until they could produce new roots. Seedlings were maintained in the nursery for about a year, until they were 0.6 to 0.9 m tall, before transplanting (35). Striplings up to 1.8 m tall have been used with good success (51).

Direct seeding has succeeded in moist areas but failed on dry sites (29). Seeding with prepared seed spots has the best chance of success and requires intensive weeding in early months.

Currently, containerized seedlings are used because the practice is less demanding of favorable weather conditions at planting and of site preparation and weed control. In the nursery, seeds are germinated in soil-filled trays and later transplanted to containers (usually plastic nursery bags) or seeds are planted directly into the containers (53). About 9 months are required to produce good seedlings. Planting should take place after the first good rain of the wet season in dry areas. In moist areas, planting can be done all year.

**Vegetative Reproduction.**—Rooting of leafy cuttings of West Indies mahogany under mist has been demonstrated (16). Seedlings, saplings, and poles sprout readily; large trees seem much less able to regrow by sprouting.

### Sapling and Pole Stage to Maturity

**Growth and Yield.**—West Indies mahogany has a reputation for slow growth (46), but this may not be entirely justified. The rate of height growth is modest and declines early, especially on poor sites. However, diameter growth is good for a dry forest species and steady over a long life.

In one large planted area in Puerto Rico, where rainfall is about 1660 mm annually and soils are only a few centimeters thick over porous limestone, young West Indies mahogany averaged 0.57 m of height growth and 1.0 cm of diameter growth during the first 7 to 8 years (29). At 53 to 54 years of age, dominants and codominants in the same plantation averaged  $16.7 \pm 0.5$  m in height and  $28.3 \pm 1.3$  cm in a diameter at breast height (d.b.h.) (author, personal observation). In another plantation in Puerto Rico with 760 mm mean annual precipitation and deep soil, 44-year-old dominants and codominants averaged 42.7 cm in d.b.h. and  $20.1 \pm 1.1$  m in height (author, personal observation). Growth rates of a number of plantations of West Indies mahogany are listed in table 1.

A dominant tree 55 years old, aged by counting annual rings, in St. Croix, U.S. Virgin Islands (1100 mm mean annual precipitation), had grown an average of 0.64 cm per year in d.b.h. throughout its life (54). The annual rings in Cuba were found to represent the age of West Indian mahogany trees accurately (11). In another location on St. Croix, 20 roadside trees had averaged an annual increment of 0.63 cm in d.b.h. over their 200-year lives (56). Mean annual diameter increments of planted West Indies mahogany vary from 0.24 to 1.6 cm (table 1). Diameter growth appears to be somewhat faster in the first decade or two after planting and depends a great deal on site quality and the growing space available. A natural stand on St. Croix was reported to support a basal area of 48 m<sup>2</sup>/ha (54).

West Indies mahogany trees are known to reach considerable ages and sizes. A row of trees, 20 of which were mea-

Table 1.—Growth rates reported for a number of West Indies mahogany (*Swietenia mahagoni*) plantings

Location	Annual precipitation	Age	Mean			Reference
			D.b.h.	Height	Annual diameter increment	
	mm	years	cm	m	cm	
Cambalache, PR	1500	46	15.4	13.0	0.33	*
Fiji (Ornamentals)	...	24	34.9	...	1.46	47
Guajataca, PR (Hilltops)	1800	7	6.6	3.8	0.94	29
Guajataca, PR (Slopes)	1800	8	8.7	6.1	1.09	29
Guajataca, PR (Sinkholes)	1800	8	9.0	4.3	1.12	29
Guajataca, PR	1800	53	28.3	16.7	0.53	*
Guánica, PR	880	30	16.1	...	0.54	3
Guánica, PR	880	59	14.2	8.0	0.24	*
Guayanilla, PR	960	44	42.7	20.1	0.97	*
Maricao, PR (Slope)	2300	8	3.9	3.0	0.48	29
Maricao, PR (Valley)	2300	18	7.8	5.5	0.43	29
Mona Island, PR	880	52	18.7	5.4	0.36	*
Nanawale, HI	2500	5	...	8.2	...	58
San German, PR	1770	11	10.2	5.3	0.93	†
St. Croix, VI	1000	7	...	3.0	...	37
St. Croix, VI (Fence row)	1000	200 <sup>‡</sup>	125.7	22.4	0.63	56
Susúa, PR (Valleys)	1500	7	5.9	3.4	0.84	29
Susúa PR (Slopes)	1500	7	4.8	2.8	0.69	29
Susúa, PR	1500	53	20.2	12.4	0.38	*
Toa Alta, PR (Thinned)	2000	35	55.9	13.7	1.60	§
Trinidad and Tobago	...	30 <sup>‡</sup>	19.4	...	0.65	30
Vieques, PR	1200	4	...	2.1	...	*

\* Author, personal observation.

† 1953 memo by Frank H. Wadsworth on file at the Institute of Tropical Forestry, Río Piedras, PR.

‡ Approximately.

§ 1931 memo by Charles Z. Bates on file at the Institute of Tropical Forestry, Río Piedras, PR.

sured, planted about 1790 in St. Croix, averaged  $125.7 \pm 5.8$  cm in d.b.h. and  $22.4 \pm 0.4$  m in height (56). A tree that measured 3.7 m in diameter was once cut and sold in Jamaica (35). Although heights on the poor sites where the species usually grows are 12 to 18 m (42), individual trees on good sites may occasionally reach 30 m in height (47).

West Indies mahogany does produce long, clear boles on very good sites. Generally, however, boles are short and sometimes crooked, especially on poor sites (fig. 3). Development of the crown follows Rauh's architectural model, in which a monopodial trunk grows rhythmically and sends out tiers of branches that are morphogenetically identical to the trunk (12).

In the absence of tested management regimes for West Indies mahogany, the following is suggested. Initial spacing should be about 3 m by 3 m. The plantation must be weeded frequently enough to keep it above the competition of weeds and brush. After about 15 years, when the crowns have closed, an early commercial thinning for fenceposts or fuelwood should be conducted to reduce the stocking to about 300 to 325 trees per hectare. Crop trees should be promoted by removing badly formed and slow growing competitors. Another similar thinning should be conducted at about 30 years to lower stocking to about 150 trees per hectare. Thinnings for small sawlogs are then conducted at about 40 and 50 years to reduce the stocking to about 75 and 40 trees, respectively. As much as possible, the best trees are retained

to concentrate value. The final harvest comes at about 60 years (on good sites) when the crop trees are about 0.5 in d.b.h. On dry and poor sites, the whole process will have to be prolonged somewhat. At the final harvest, a stand of saplings and small pole-sized West Indies mahogany should be available for management in the next rotation. Natural stands with an important component of West Indies mahogany can probably be regenerated by group selection, single-tree selection, shelterwood, or seed-tree techniques. Advanced regeneration is normally present in older stands, and clearcutting should result in suitably stocked stands.

**Rooting Habit.**—Seedlings produce a strong taproot. Taproots of older trees in clay soil are not much larger than the numerous sinker roots arising from large lateral roots (author, personal observation). However, the taproots of West Indies mahogany are described as being thick and conical, and the extraction of taproots for wood even one or two centuries after harvest is proposed (41). Probably the degree of taproot development in older trees depends on the degree of aeration of the subsoil. West Indies mahogany trees form small- to medium-sized buttresses and produce many large lateral roots at or near the surface. These roots often damage sidewalks and curbs (42, 43).

**Reaction to Competition.**—West Indies mahogany is intolerant of shade. Seedlings can survive for extended periods in the understory of dry forest, but overtopped trees weaken and eventually die (author, personal observation).





**Figure 3.**—West Indies mahogany (*Swietenia mahagoni*) trees growing on poor sites usually are short and develop with poor form.

Young trees are often able to survive and grow up through weeds and brush, especially in dry areas.

**Damaging Agents.**—West Indies mahogany is resistant to wind (hurricane) damage (55). Naturalized stands and ornamental trees on St. Croix survived Hurricane Hugo in 1989 (gusts in excess of 240 km per hour), with defoliation and some branch breakage but little trunk snapping. Wind throw, where it occurred, was confined to soils with poor rooting depth (author, personal observation).

The mahogany webworm (*Macalla thyrsialis* Walker), which occurs throughout the native range of the mahoganies, can cause defoliation and unsightly webbing (15). Under humid nursery conditions, *Phyllosticta swietenia* causes a seedling leafblight that results in some defoliation in Puerto Rico (1).

West Indies mahogany is reported to be more resistant to mahogany shoot borer, *Hypsipyla grandella* Zell., than Honduras mahogany, *Swietenia macrophylla* King (10). There are relatively few shoot borer attacks on West Indies mahogany in Puerto Rico and St. Croix (59). Shade and plantation trees in Asia are attacked by *H. robusta* Moore (18). In Puerto Rico, the coffee tree borer, *Apate monacha* F., can cause serious damage by boring into young trees and logs (31, 32). An unidentified shoot borer (not *H. grandella*) is reported to attack West Indies mahogany in plantations in Haiti without causing significant growth reductions (45).

Dead branches and occasionally trunks are frequently consumed by the wet-wood termite, *Nasutitermes costalis* (Holmgren) (32). West Indies mahogany wood is very resistant to attack by the West Indian dry-wood termite, *Cryptotermes brevis* (Walker) (61). However, the wood showed little resistance to marine borers (*Teredo* spp.) in Hawaiian waters (7). Sapwood as lumber or in furniture is susceptible to attack by the powderpost beetle, *Lyctus caribeanus* (Lesne) (32).

West Indies mahogany heartwood showed greater resistance to rot than heartwood of *S. macrophylla* King or *Khaya* spp. (African mahogany) when incubated with three species of wood-rotting fungi for 3 months (34). Heartrots and buttrots that apparently enter through wounds and branch stubs are quite common in older West Indies mahogany trees. The commercial volume lost in one stand was estimated at 20 percent (54).

### SPECIAL USES

West Indies mahogany was once the best known and most prized tropical cabinet wood in the world (26). Nearly all the high-quality Chippendale furniture produced during the middle 1700's was made from this wood (14). West Indies mahogany wood was exported in quantity from the Greater Antilles islands for 400 years until the supply ran out early in the 20th century. So great was the demand that discarded butt logs too heavy to handle in logging operations decades to centuries before was salvaged (14). Small quantities of West Indies mahogany logs are still harvested from plantations and depleted natural stands. The demand for "mahogany" wood is now largely satisfied with *S. macrophylla*, *Khaya* spp., other members of the Meliaceae, and other substitutes.

West Indies mahogany heartwood varies in color from a deep, rich red to pink or yellow but darkens to a deep red or brown with age and exposure (26). The sapwood is yellow to white. The texture is fine and the grain is straight to roey, wavy, or curly. Its surface is highly lustrous with a silky, golden aspect. The wood in furniture is frequently stained red brown, but the practice actually hides much of its natural beauty.

Density when oven-dried is reported at 0.61 g/cm<sup>3</sup> in wood from Cuba (13) and 0.60 g/cm<sup>3</sup> in that from Hispaniola (17). Wood density (apparently air-dried) is reported to vary in Jamaica from 0.54 to 0.83 g/cm<sup>3</sup> (50). Air-dried samples from Cuba showed an average modulus of rupture of 276,000 newtons/cm<sup>2</sup>, a modulus of elasticity of 34,000 newtons/cm<sup>2</sup>, a crushing strength of 179,000 newtons/cm<sup>2</sup>, and a side hardness of 5,900 newtons (13). Almost identical values were obtained with a test sample from Hispaniola (17). These strength properties are a little higher than those exhibited by English oak (*Quercus robur* L.) (26).

West Indies mahogany is easy to work with both hand and power tools. It glues, bends, and finishes well and makes excellent veneer and turned items (26). Some regard it as somewhat hard for modern high-speed machining (38).

West Indies mahogany is easily air or kiln-dried without warping or checking. Shrinkage from green to oven dry is low. Five samples from Cuba averaged 2.7 percent radial, 3.3 percent tangential, and 6.0 percent volumetric shrinkage

(13). Another sample from Hispaniola shrank 4.6 percent radially, 5.4 percent tangentially, and 6.9 percent volumetrically (17). Small differences in radial and tangential shrinkage give it excellent stability during use (26).

In areas where it grows, West Indies mahogany wood is used for custom-made furniture, balustrades, trim, carving, and crafts. In Europe and the United States, it is used chiefly for repair and reproductions of Victorian- and Georgian-era furniture (38). In the West Indies, small trees and limbs are used for fenceposts, firewood, and charcoal making.

The species is an important shade and ornamental tree in the West Indies and a number of other areas in the tropics (35, 42, 47). Infusions of West Indies mahogany bark are strongly astringent and are used in herbal medicine to treat influenza and other ailments (39). The bark is high in tannin (25) and probably could be used to tan leather. The flowers provide nectar for bees (25). Extrafloral nectaries have also been documented in West Indies mahogany (19), but it is not clear what insects these may benefit.

## GENETICS

There are three species of *Swietenia*, all from tropical America (24). The species name, *mahagoni*, was an adaptation of an early local name of the tree in Jamaica (33).

The chromosome number of West Indian mahogany was found to vary in a polyploidy series,  $2n = 12$  to  $60$  (49). Chromosome number for West Indian mahogany trees collected in India was reported to be  $n = 28$  (40).

*Swietenia macrophylla* and West Indies mahogany freely interbreed when they grow near each other. The interspecific hybrid has been noted and cultivated in a number of areas (21, 27, 30, 47, 60). The hybrid has been shown to grow faster than either parent in tests of early growth (4, 22, 27). The F<sub>2</sub> generation is reported to segregate into the parent species and the hybrid according to the Mendelian ratio 1:2:1 (27). In Puerto Rico, many areas now have a swarm of the parent species and F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub> generation hybrids with leaf, bark, capsule, and seed characteristics running the gamut from one species to the other (author, personal observation). *Swietenia* spp. are normally outbreeding, but can set high quantities of seeds by self-pollination (62).

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